Guidelines for the Design and Use of Bottomless Sand Filters

January 2003

Attached are the "Guidelines for the Design and Use of Bottomless Sand Filters" (BSF Guidance Document), which is intended to complement the Sand Filter Guidance Document (SFGD) issued by the Department of Environmental Management (DEM) in April 2000. That document provides detailed guidance for the design and use of Recirculating Sand Filters (RSFs), Single-Pass Sand Filters (SPSFs) and the Pressurized Shallow Narrow Drainfield (PSND).

Training Required

Any design incorporating a BSF must be designed by a Class II or III Licensed ISDS Designer. As of November 2002 no designer or installer shall undertake the design/installation of a BSF pursuant to regulations unless he/she has received appropriate training for this purpose. Any licensed designer or installer whose work on a BSF demonstrates a need for further training may be required to obtain such training prior to executing further work pursuant to the license. Information on training is available at the DEM website http://www.state.ri.us/dem- select “Programs”, “Water Resources”, the “Professional Licensing” icon, “ISDS”. A link titled “Continuing Education” is available on the left side of the screen.

Summary of BSF Applicability and Specifications

The bottomless sand filter (BSF) is a viable drainfield option for individual sewage disposal systems (ISDSs) where soil or site conditions make conventional drainfield options impractical or excessively costly. As compared to conventional technology, the BSF requires significantly less filling of land, less soil disturbance, and eliminates the need for unsightly retaining walls on sites with certain limiting conditions including shallow water tables, restrictive soil layers, or moderate to steep slopes. The BSF is also preferable to the pressurized shallow narrow drainfield (PSND) where site conditions would otherwise require that the PSND be placed in fill above the existing land surface.

A typical BSF is 15 feet long by 10 feet wide and 2.5 feet deep. The sides are formed with a structural support such as large landscape timbers and the interior is faced with plywood and 30 mil PVC liner material. The formed box is filled with specially graded sand and is capped by a 6-inch thick layer of coarse pea stone gravel at the surface. The top of the BSF is exposed and is raised between 0.5 feet to 2.5 feet above the existing land surface. Treated wastewater is intermittently pumped into a network of perforated pipes buried in the pea stone gravel, where the wastewater enters the filter and moves vertically downward by gravity, receiving further biological treatment. Unlike the RSF and SPSF, where filtered effluent is collected and directed to a separate drainfield, treated effluent exiting the BSF enters the natural soil directly beneath the filter.

Wastewater discharged to a BSF must receive prior advanced pretreatment. Wastewater directly from a septic tank is too concentrated and will cause fouling. Thus, a key requirement for employment of a BSF is that it may only be used in conjunction with another advanced treatment technology.

The Department recognizes the bottomless sand filter to be equal or superior to conventional leachfield technologies for single-family home systems and will authorize the use of bottomless sand filters as an accepted equivalent drainfield under the Department’s Individual Sewage Disposal Regulations. Important restrictions and other provisions apply and are detailed on page 2 of the document. The technology is listed on DEM's approved list of Innovative or Alternative (IA) Technologies. The use of the technology will not require a variance from the Department provided the design and installation of each system is in compliance with the guidance and all other ISDS regulations.

The recognition of the BSF as noted herein does not represent a DEM standard. A designer may submit other designs (an engineered system) employing similar concepts, with appropriate supporting information and justification, for DEM review and consideration on a case-by-case basis through the variance process. Vendors with proprietary technologies are encouraged to submit technology applications under the IA Technology provisions in the ISDS regulations.

Acknowledgements
The BSF Guidance Document was originated and authored by George Loomis, David Dow and Terri Gentes of the University of Rhode Island On-Site Wastewater Training Center. The Technical Review Committee for IA Technology (TRC) provided input and guidance on several drafts of the document and has recommended its adoption and publication. DEM gratefully acknowledges and thanks the principal authors for the development of the document, and the TRC and all other reviewers for their advice and critical comments.

Comments?
The department encourages review and constructive criticism on the contents of the BSF Guidance Document. It is our intent to periodically review and revise the guidance as appropriate. Comments may be sent to: ISDS Program, Office of Water Resources, RIDEM, 235 Promenade Street, Providence, RI 02908 or by e-mail to: wresourc@dem.state.ri.us. Please consult DEM's website – www.state.ri.us/dem – for the most up-to-date version of the guidance and a listing of other approved IA technologies.

Rhode Island Department of Environmental Management

Guidelines for the Design and Use of Bottomless Sand Filters

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Special Provisions For Use of BSFs pursuant
RI Department of Environmental Management ISDS Regulations

- Sizing of the BSF is based on soil texture, structure and consistence. Where a soil evaluation by a Class IV Soil Evaluator has not been performed, the designer shall have an analysis of these soil characteristics performed sufficient to make a determination on sizing.

- The interior face of any structural or landscape retaining wall that may interfere with groundwater flow must be located at least 25 feet from the BSF.

- The minimum setback distance from the BSF to any dwelling shall be eight (8) feet, provided that the elevation of the basement slab in the dwelling is at or above the design seasonal groundwater table (SHWT) depth.

- Where design flows exceed 900 gpd, DEM may require additional technical studies to ensure that the soil will accept and transmit effluent at the proposed loading rate without: excessive mounding of groundwater; seepage outbreak, such as at nearby cut slopes, toe slopes or property boundaries; adverse effects on the operation of the BSF; or adverse effects on nearby groundwater and surface water resources.

- Where the BSF is proposed on a lot within a high density neighborhood where drinking water is supplied by individual onsite wells, DEM will require that the advanced treatment accompanying the BSF include an approved nitrogen-reducing technology if the applicant cannot demonstrate that a conventional leachfield meeting all current regulatory requirements could be constructed on the lot. For purposes of this provision, a neighborhood where lot sizes are typically less than 20,000 square feet may be considered high-density.

- All setbacks and all other regulatory requirements contained in the ISDS regulation shall be met.

- Any design incorporating a BSF must be designed by a Class II or III Licensed ISDS Designer. Beginning one year after the adoption of the BSF guidance document by the department, no designer or installer shall undertake the design /installation of a BSF pursuant to regulations unless he/she has received appropriate training by a vendor, professional organization, or institution recognized by DEM for this purpose. Any licensed designer or installer whose work on a BSF demonstrates a need for further training may be required to do so prior to executing further work pursuant to the license.

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PREFACE

The purpose of this document is to provide an orderly guideline for the design and review of bottomless sand filters for the treatment and dispersal of residential strength wastewater. This document uses various terms to describe the *level of importance* of different design criteria. The terms used are:

1. May: Optional, but consider this criteria.
2. Should: Optional, but a well-accepted practice. A wise or advisable choice.
3. Must or shall: Not optional. The wastewater field's present state of knowledge mandates use as described.

A glossary of wastewater terms is included to help familiarize the reader with new terminology. Figures referenced in the text are located in Appendix A of this document. These guidelines are not intended to be a step-by-step procedure to designing and installing systems utilizing bottomless sand filters. They are intended to provide general information to the designer, installer and maintenance provider concerning bottomless sand filters.

1. 0 INTRODUCTION

The use of sand media to treat wastewater has been practiced with good success for well over one hundred years. The use of bottomless sand filters expands upon the design and use of packed bed filters already permitted in Rhode Island and throughout the country. Bottomless sand filters are a viable drainfield option to use after highly treated wastewater where certain site and soil conditions exists that would make the use of conventional or shallow narrow drainfields impractical or not economical.

1.1 Coverage of Guidance Document

This guidance document is intended for the design of Bottomless Sand Filters (BSFs) as drainfield options for new systems and repairs. A BSF must follow an advanced treatment unit(s) that has been approved by the Department to meet, at a minimum, the following treatment levels: biochemical oxygen demand (BOD_5) of 30 mg/l; total suspended solids (TSS) of 30 mg/l; and fat, oil, and grease (FOG) of 5 mg/l. **BSF shall not be used as a drainfield option for septic tank effluent.**

BSF designs vary somewhat depending upon the level and reliability of treatment occurring in the preceding advanced treatment unit. For instance, loading rates are higher for BSFs that follow time-dosed treatment units, resulting in smaller BSFs. For purposes of this document, all advanced treatment units, specified to precede a BSF, must fall within one of the following categories:

> **Category 1 Systems**: Advanced treatment units that are **timed dosed** and have been classified by the Department as meeting effluent standards less than or equal to 20 mg/l for both BOD_5 and TSS; and FOG of less than or equal to 5 mg/l.

> **Category 2 Systems:** Advanced treatment units that are **<u>not</u> time dosed** and have been classified by the Department to at least meet effluent standards of 30 mg/l for both BOD_5 and TSS; and FOG of less than or equal to 5 mg/l.

<u>1.2 Treatment Process Summary for BSF</u>

Wastewater, having received secondary or better treatment in advanced treatment unit(s), is intermittently pressure dosed using a programmable timer to a bed of specified sand media. Wastewater is dispersed over the bottomless sand filter surface in a PVC pipe distribution network surrounded in peastone. Wastewater trickles down in unsaturated thin film-flow through the sand media, where physical and biological treatment occurs. The small size of particle media promotes straining and subsequent removal of pathogenic organisms. The treated wastewater (bottomless sand filter effluent) infiltrates into the underlying native soil, where it may receive additional treatment as it percolates down through air-filled soil pore space, before entering the saturated zone.

2.0 SITING GUIDELINES

<u>2.1 Why and Where to Use a BSF</u>

BSFs should be used as a final drainfield option when site characteristics and space constraints are such that pressurized shallow narrow drainfields (PSND) or conventional trenches require filling, inverts are above existing grade, shallow water table or restrictive layers prevail, or other site conditions exist. Using a bottomless sand filter often will eliminate the need for excess fill required of other drainfield options. BSFs can be placed along fence lines or cut into a mildly sloping site to provide an aesthetically acceptable appearance.

In addition, BSFs may be used in areas where maximum removal of pathogenic organisms is desired. Applicable locations for the BSFs are: drinking water reservoir watersheds, pathogen sensitive poorly-flushed coastal ponds, shallow water table soil locations, densely populated welled areas, sites in close proximity to shell fishing grounds, and areas where recreational water contact issues are a concern. To maximize pathogen removal in these areas, BSFs should be constructed above-grade in a location where only the grass thatch layer and/or organic matter has been stripped. Native A and

B mineral soil horizons, when left in place and undisturbed below the base of the BSF, can help provide additional pathogen removal (See Figure 5).

Regardless of the application, BSFs should only be used as the final dispersal option where the advanced treatment system provides for at least secondary treatment of the wastewater prior to entering the BSF (see treatment levels in Section 1.1).

2.2 Vertical Separation Distances

All vertical separation distances defined in the State regulations must be meet when using a BSF. The vertical separation distance shall be measured from the peastone-sand interface, directly below the PVC distribution manifold, to the seasonable high groundwater table or to impervious surfaces as defined in the State regulations. (See Figures 5 and 6)

2.3 Precautions

The home landscape immediately adjacent to any BSF system should be protected from heavy vehicle traffic and excessive weight loads, before, during and post-construction. It is recommended that the proposed system location be staked and flagged/fenced to prevent encroachment during home construction. If vehicle encroachment is expected to be a problem after construction, some structure such as garden timbers, fences, or walls should be used to protect the BSF filter area.

3.0 SAND FILTER LOADING RATES & DESIGN GUIDELINES

All bottomless sand filters shall be designed according to the following:

(a) The **hydraulic loading rates** for BSFs will be based on the native receiving soil characteristics and the quality of wastewater being discharged by the preceding secondary treatment unit. These rates are provided in Table 1. Designers should be aware of the typical filter dimensions available from manufactures that provide pre-drilled and cut sand-filter components. To avoid extra cost to the homeowners associated with custom-sized filters and to reduce installation time, designers should select the nearest standard manufactured size that meets the required minimum loading rates provided in Table 1.

(b) All bottomless sand filters under this guidance shall be **pressure dosed utilizing programmable timers**. (See Section 4.3). If an advanced treatment unit is used which is time-dosed (Category 1 Option) this timer shall also control the application of influent to the BSF.

(c) If a BSF does not follow a time-dosed unit, routine hydraulic surge storage capacity in the tank from which effluent is pumped onto the BSF is required. This surge storage capacity shall be positioned between the elevation of the timer operating float switch and the high water alarm/timer override float switch (See Section 4.1).

(d) To reduce the possibility of ground water mounding problems, it is recommended that the **length to width ratio of any BSF be between 1.5:1 and 10:1.** (The BSF distribution manifold runs the width of the BSF, whereas, the laterals run the length of the BSF). Also, an attempt should be made to position all filters, lengthwise along the existing site contours rather than into the contours. Care shall be taken to ensure structural integrity of all filter enclosures.

(e) The finished grade of any bottomless sand filter should be a minimum 6 inches above the elevation of the surrounding finished grade to prevent surface water from flowing onto the filter. One layer of secured landscape timbers (minimum nominal dimensions of 6" x 6") shall be placed around the top perimeter to emphasize the filter's location so that accidental vehicle movement over the filter can be prevented. Additional timbers should **not** be placed below grade since they will rot with time and leave a void that could result in soil slumping around the BSF (See Figure 6). The timbers may be secured with iron pins, rebars, or stakes and fastened to the support walls to prevent movement.

(f) The land surface elevation 2 feet below the peastone sand media interface shall be maintained for a distance of 5 feet from the edge of the BSF (See Figure 5). Land surface regrading adjoining this 5-foot perimeter must maintain a minimum of 3:1 slope down gradient.

(g) In welled areas, an alternative area for a BSF, which meets all requirements presented in this document, must be available in case of failure of the original BSF.

3.1 Precautionary Notes

(a) The proposed BSF location shall be staked out and protected prior to any site preparation activities.

(b) BSF shall not be buried, or covered by topsoil, or covered with any other material since that may limit gas/oxygen movement into and out of the filter or interfere with proper maintenance. In areas where the BSF may be accessible to children, the peastone surface may be covered with a broad weave filter fabric and an additional layer of peastone or larger washed stone, no greater than 2 inches in thickness, to discourage physical disturbance to or contact with the treatment zone.

(c) BSF should not be placed in a depressional area on a property, where storm water is likely to collect during rainfall events.

(d) A minimum buffer of ten (10) feet should be maintained between BSFs and neighboring trees and shrubs. The root systems of water-loving trees and shrubs can cause damage to BSFs. If the 10-foot buffer is not maintained, then a root

barrier fabric (available through a wholesale plant nursery company) shall be placed between the trees and the filter.

(e) Under no circumstances should heavy equipment, vehicles, or impermeable surfaces/materials be allowed over a finished BSF. At a minimum, this would result in poor treatment. More likely system failure, broken components, and financial expense to the homeowner will result.

Table 1. Hydraulic loading rates for bottomless sand filters.

Soil Category	**Predominant USDA Soil Texture of Receiving Soils**	**Soil Structure**	**Soil Consistence**	**Category 1* Systems Loading Rate** gal/ft^2/day	**Category 2* Systems Loading Rate** gal/ft^2/day
1	cos, s, lcos, ls, cosl, and gravelly soils	structureless- single grain	Loose	3.0	2.0
2	vfs, fs	structureless- single grain Structureless-massive	Loose Very friable	3.5	2.5
3	lfs, ls, fsl, sl	granular, subangular blocky	very friable to friable	4.5	3.0
4	lvfs, vfsl, sil	granular, subangular blocky	very friable to friable	4.0	2.6
5	lcos, ls, cosl	subangular blocky	friable	3.5	2.3
6	lfs, ls, fsl, sl	structureless-massive	friable	3.0	2.0
7	fsl, vfsl, sil, si	structureless-massive	very friable or friable	2.8	1.9
8	lcos, ls, cosl	structureless-massive	firm to very firm	2.5	1.7
9	fs, sl, l, fsl, vfsl, sil, sicl	platy, structureless-massive	firm to very firm	2.0	1.3
10	All textures	structureless-massive	extremely firm	Not allowed	Not Allowed

* Category 1 systems = any advanced treatment unit that is **time dosed** according to the specifications of this guide and has been classified by the Department as meeting treatment standards of less than or equal to 20 mg/l for both BOD and TSS and FOG of less than or equal to 5 mg/l.

* Category 2 systems = any advanced treatment unit that is **not time dosed** according to the specifications of this guide and has been classified by the Department as meeting treatment standards of 30 mg/l or less for

both BOD and TSS and FOG of less than or equal to 5 mg/l.

Notes:

1. Soil textures are defined in the glossary.
2. Loading rates shall be based upon texture, structure, and consistence of the most restrictive horizon within 1.5 feet below the proposed base of the BSF.

4.0 SYSTEM COMPONENTS

Bottomless sand filters submitted under this guidance shall be **pressure dosed utilizing programmable timers**. Intermittently pressure-dosed effluent provides uniform distribution of wastewater over the filter surface, minimizing the chance of localized saturation in the filter. In addition, small incremental wastewater applications promote better wastewater treatment than a few large doses. Use of a programmable timer enables peak flows to be stored in tanks and time dosed to the bottomless sand filter surface over a 24-hour clock cycle.

If an advanced treatment unit is used which is time-dosed (Category 1 System) this timer alone will indirectly control the application of influent to the BSF. In this case, a second timer for the BSF is not required. Effluent from a Category 1 System can be demand dosed from the pump chamber dosing the BSF since it will have been time-dosed earlier in the treatment train.

4.1 Pump Chamber Specifications

(a) A pump chamber must be provided following the advanced treatment step to provide wastewater storage and to house the pump discharge assembly. All chambers used in a BSF system **must be watertight**, otherwise the system will not function properly. Leaks will allow groundwater to infiltrate into the chamber and be pumped onto filters, subsequently overloading them. Similarly, under deep groundwater conditions, wastewater leaking out of a chamber will not be dosed to the bottomless sand filter and treatment will be short-circuited. All inlet and outlet pipes to concrete chambers shall have flexible rubber seals secured by stainless steel bands. Watertight rubber grommets must be used at inlet and outlet pipes to plastic or fiberglass pump chambers.

(b) A pump chamber dosing effluent from Category 1 System(s) (time-dosed) shall provide storage volume equal to the design volume dosed onto the BSF during one pump run time.

(c) A **storage capacity** must be provided in BSF pump chambers that follow Category 2 Systems to accommodate power outages, service periods, or surge flows. The storage capacity volume above the working level of the programmable timer operating range shall be positioned below the pump high water alarm. The high water alarm shall be placed a minimum of 2 inches below the invert of the inlet to the basin.

(d) Pump chamber following advanced treatment units that are not time-dosed (Category 2 Systems) shall be a minimum of 450 gallons and provide for surge storage of fifty percent (50%) of the daily design flow. If 50% of the daily design flow is greater than the storage provided by a 450-gallon tank then a larger tank must be specified.

In situations where BSFs are being designed for seasonally-used vacation homes and summer rental homes, where daily design flows may often be exceeded, it is strongly recommended that primary tank and pump chamber capacities be increased by a minimum of thirty (30) percent.

4.2 Pump and Transport Line Specifications

(a) Pressure Requirements - Pumps should be sized to provide a minimum of two (2) feet of head (i.e. pressure) at the distal end of each distribution lateral in the BSF. Most pump manufacturers will provide pump calculations for individual designs and requirements.

(b) Electric / Wiring Requirements– Pumps dosing BSFs following a Category 2 System shall be wired on the same electrical circuit as the advanced treatment unit.

(c) Transport Lines - The effluent transport line from the pump to the BSF shall be a 1 ¼ to 2 inch PVC (Class 200 minimum) pipe. The actual size will depend upon such factors as distance, pump head, friction loss, and desired pressure at distal orifices. This pipe should be sloped either back to the pump basin or onto the BSF to clear the line after each dose. Transport piping is sloped to prevent freezing in cold weather. **Check valves will prohibit free flow and must not be used if the transport line slopes back to the pump basin.** If the transport pipe slopes towards the BSF with distribution piping at a lower elevation than the maximum water level in the pump basin, an anti-siphon device should be used on the pump discharge assembly to prevent siphoning.

If a transport line cannot be drained, then a 2-foot minimum burial with 2” thick by 24” wide expanded rigid polystyrene plastic insulation must be placed above the pipe. Insulation may not be necessary if piping is installed below the frost line.

(d) All pumps following Category 2 Systems must have either a screened vault or an in-line effluent filter.

4.3 Programmable Timer

(a) The timer shall be programmed to provide several small doses of wastewater to the BSF throughout the day.

i. The system design shall be based upon 1 to 2 doses per hour.
ii. The designer shall insure that the timer is field-set at the time of system start up.

iii. Two to four weeks after sufficient use of the system, the designer shall ensure that the timer is reset, as needed, based upon actual flow through the system. Depending upon the actual flow to the system at that time, as few as 10 doses per day may be adequate to disperse flow to the BSF.
iv. Timer settings shall be checked at every established maintenance and inspection visit and adjusted as needed.

(b) A high water alarm, pump, and float switch(s) set to override the programmable timer in the event of timer malfunctions or temporary excessive water use must be provided. A low water redundant off is recommended.

(c) A pump control panel with an elapsed time run meter and a dosing event counter (pump impulse counter) for each pump in the system is necessary. The elapsed time run meter and dosing event counter should be non-resettable.

(d) An impulse counter on the timer override or high water alarm float (whichever is most applicable) is required. This counter would indicate how often the system is working in override or high water situations.

(e) The pump control panel box must be placed on an outside wall of the structure that it serves. This will enable the system to be serviced at any time; eliminating the need to access the inside of the building. It is strongly recommended that the panel box also be within view of the system location to help facility operation and maintenance.

4.4 Sand Filter Enclosures

(a) The walls must be lined with a 30 mil PVC liner with all boots, patches, repairs, and seams having the same physical properties as the liner material.

(b) Any penetration through the PCV liner wall shall be done with a PVC boot attachment glued to the liner with the appropriate resilient sealer.

(c) Support walls are needed to prevent caving of the filter walls during construction. These walls shall be rigid and made of plywood (or equivalent) and 2x4 support boards.

(d) A permanent top frame structure (such as decay resistant landscape timbers) must be provided on any portion of a BSF that is installed above grade. The perimeter of the BSF, below the required perimeter of 6” high landscape timbers, may be bermed with native soil or other material such as landscape stone or other non-degrading material. **Below grade use of timbers is prohibited to prevent soil slumping after timbers have rotted and to spare the homeowner additional expense.**

4.5 Sand Filter Media Specifications

(a) The BSF filter media specifications are presented in Figure 9. All media within the enclosure and below the peastone must meet the requirements for ASTM C-33 Sand with an effective size (D_{10}) of 0.3 mm and uniformity coefficient (D_{60}/D_{10}) of 3.0 to 4.0. The maximum allowable percentage of fines passing through a Number 200 sieve shall be 1%.

(b) Sand Quality **- It is important to remember that using good quality sand media is essential. Not all sand and gravel operations will have the ability to produce sand with these specifications.** A sieve analysis of the sand media to be used should be conducted to assure that its effective size and uniformity coefficient are appropriate. When sampling the stock piled sand media, samples should be taken from several locations within the pile to assure a representative sample for analysis. The standard method to be used for performing particle size analysis should comply with one of the following:

1. The sieve method specified in ASTM D-136 and ASTM C-117.
2. The method specified in Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples, Soil Survey Investigation Report #1, U.S. Department of Agriculture, 1984.

4.6 Distribution Laterals

(a) Influent applied to a BSF is distributed over the sand surface using small diameter, pressure rated PVC pipe. For the BSFs in this guideline the distribution manifold will typically be 1 to 1¼ inch PVC (Class 200 minimum) and the distribution laterals usually will be ¾ to 1 inch Schedule 40 PVC. Size will vary depending on design and site conditions. (Note: Small lateral and orifice sizes are recommended to provide the highest possible scouring velocity in the laterals, minimize orifice clogging, and provide as even distribution of wastewater as possible.) **Individual laterals shall be no longer than 50 feet**.

(b) Orifices - A series of 1/8 inch diameter holes (orifices) shall be drilled in the distribution laterals and spaced no less than 14 inches and no more than 24 inches apart. The laterals shall be installed with all orifice holes pointing down (6 o'clock position) covered by orifice shields with slots or holes to provide free draining (usually referred to as cold weather orifice shields). See Figure 8.

All BSFs covered by this document shall be dosed up to a maximum of 0.25 gallons per orifice per dose. Pump manufacturers will usually help provide pump calculations to assist with this design requirement.

(c) Lateral Spacing - Laterals shall be spaced between 15 inches and 24 inches on center.

(d) Designs should account for a minimum of two (2) feet of head (pressure) at the distal end of each distribution lateral. The maximum head differential between the first and last orifice on each lateral shall be no greater than 10%.

(e) The distal end of each BSF lateral should be closed off with either a ball valve or a threaded end cap (See Figures 5, 6 or 8). **Sweep elbows shall not be used at the end of bottomless sand filter laterals (See maintenance section)**.

4.7 Inspection Well

(a) One inspection well shall be installed in the approximate center of the filter and extend down to the sand and native soil interface (See Figures 5,6 and 7). The inspection well should be made of 4-inch diameter perforated or slotted PVC pipe (SDR 35 minimum) wrapped in filter fabric and topped with removable cap at grade.

5.0 INSTALLATION SPECIFICATIONS

The proposed BSF location shall be staked out and protected prior to any site preparation activities. Over digging the sand filter hole should be avoided; minimal backfilling on bottom and sides provides a more stable enclosure.

5.1 Installation of Sand Filter Media

(a) Sand media shall be selected based on the requirements in Section 4.5.

(b) Sod, vegetation, or dead or decaying organic litter shall be removed from the area planned for the BSF installation. Three (3) inches of the native soil material shall be scarified and mixed with 3 inches of the sand media. **Perimeter stripping and excavation of soil beneath the native soil / filter sand interface is prohibited.**

(c) All sand filter media within the enclosure and below the peastone must meet the requirements of ASTM C-33 and must be a minimum of twenty-four (24) inches deep. It is strongly recommended that the excavator/backhoe bucket used to place media in the filter be washed thoroughly to remove any mud or fines before the loading process begins.

(d) It is recommended that the sand media be placed in level eight (8) inch lifts in the filter and wetted slightly during installation to promote even settling. It is important not to wet the sand too much because particle stratification may occur.

(e) As the filter is filled with sand, the edges of the filter should be "walked down" by the installer to make sure sand is tight along the filter perimeter, and no voids exist. The installer should watch that the liner is not stretched during the filling process. Also, the person(s) walking inside the filter should have clean shoes to avoid contaminating sand media with construction site mud or fines.

(f) After the required amount of filter sand has been added to the filter, place three (3) inches of 3/8" washed pea stone over the filter sand. After the distribution laterals have been installed atop the pea stone add three (3) more inches of pea stone to cover the distribution laterals. **No filter fabric of any kind should be placed between the sand and overlying pea stone layers.**

(g) The outside of the liner walls that are below grade shall be backfilled evenly as the filter sand is placed into the enclosure. This will prevent the walls from bowing outward as the filter is filled with sand media.

5.2 Final Installation Steps

BSFs shall not be covered by topsoil or any other cover material since this will limit the gas/oxygen movement into and out of the sand filter.

(a) Head-Requirements - Immediately after any BSF system has been installed, the head or "squirt height" of the distribution laterals needs to be determined, recorded in the maintenance record and left on site (usually in the system electrical control box). Measuring the head is done by opening the ball valve and attaching an adaptor to the threaded end of the lateral or ball valve (See Figure 5). Turn the pump on and measure and record the wastewater height in a clear PVC measuring pipe.

6.0 OPERATION AND MAINTENANCE REQUIREMENTS

WARNING - Before doing any work on either the wiring to the level control floats and pumps in the vault, tanks, or on the control panel, pull the fuse and/or switch all the circuit breakers serving the control panel to the OFF position. Do not enter a confined space without using proper equipment and following standard confined space safety precautions.

6.1 Alarms

(a) In the event of an audible alarm on the pumps controlling the dosing to the BSFs, the alarm may be silenced by pushing the red button on the outside of the control panel. In many cases the alarm will be due to a temporary high water situation caused by too much water entering the system at a particular time. This will be self-correcting in most cases. If the alarm keeps coming on, or if the red light on the outside of the panel stays on for a prolonged period of time after the alarm is silenced, there may be a more serious problem that needs to be addressed by the system maintenance provider.

(b) The high water alarm will come on if the volume of water used at a particular time is more than what is accommodated for discharge in the usual programmed dosing process. An alarm may go on if the water use of the house or facility is more than typical. These are referred to as “nuisance alarms” and do not mean there is a system problem. If the nuisance alarms persists, the dosing schedule and amounts can be changed to help correct the problem. In some cases, persistent alarms may indicate a more serious problem that needs to be addressed by the system maintenance provider.

6.2 Site Visits

At each of the operational and maintenance visits, readings from elapsed run time meters, event counters, and water meters shall be recorded on the data cards (usually stored in the electrical control panel).

At each site visit, a sample of the BSF **influent** should be collected at the pump chamber or lateral end of the BSF to visually check the clarity achieved by the advanced treatment unit. This sample should be clear of fines and/or organic matter and be relatively free of septic odors.

6.3 Component Maintenance

(a) Laterals - To remove accumulated solids in laterals, first open the lateral end ball valve or threaded end cap, engage the pump and flush out any solids. A bottle brush (appropriately sized for the lateral) attached to a plumbers snake is then pushed down each lateral to unplug the orifices. With the bottle brush removed, the pump should again be manually engaged and each lateral line flushed out through the lateral end onto the peastone. (Particularly dirty or maintenance-neglected laterals should be flushed directly into a bucket by using a garden hose and threaded fitting assembly. This waste material is then dumped into the inlet end of the system septic tank). Alternatively, a pressure power washer with appropriately sized tubing can also be sent down each lateral to flush accumulated solids.

Usually a BSF in continuous use will require lateral flushing / bottle brush treatment once a year. BSFs operating above their daily design flow may require more frequent lateral flushing. This frequency can be based upon the results of the distal lateral head pressure test. Seasonally-used BSFs may not need yearly lateral flushing, but their lateral head (pressure) should be checked once per year, and maintenance performed as needed.

(b) Filter Surface - The peastone surface of all BSFs should be kept free of debris, weeds, and grasses. This surface can be lightly raked to remove any leaves. Weeds and grasses should be removed when they first appear.

(c) Electrical Components - Once a year all electrical components should be checked for function. All float switches should be activated and timers should be checked against the desired setting. (A shortened cycle can be set to check timer function, but ensure that it is reset back to original settings once the test is complete.) All float switches should be hosed down to prevent scum accumulation. All wiring should be neatly bundled and placed out of the operating path of the float switches.

(d) Tank and Chamber Maintenance – The septic tank and pump chambers should be measured for sludge and scum accumulation. This should occur every 1-3 years, the frequency depending on household usage and occupancy. More actively-used systems should be placed on the more frequent sludge/scum measurement schedule. This can easily be done as part of the annual maintenance. If sludge and scum levels warrant, those tanks shall be pumped and accumulations removed.

IMPORTANT! If fiberglass or polyethylene tanks are used, it is important to monitor ground water levels before pumping septage or to schedule pumping of tanks for late Summer or early Fall to avoid tanks floating (this time period may differ depending upon weather conditions). Pumping concrete tanks during periods of high groundwater may also cause tank floatation problems. Careful consideration should be paid to tanks close to tidal zones, where groundwater level may fluctuate daily due to tidal influence. The yearly inspection process will facilitate the scheduling of tank pumping to avoid emergency pumping situations. All tanks should be filled with tap water immediately after septage pumping is completed.

(i) All effluent filter(s) should be hosed off on a yearly basis, and whenever the tanks are pumped. Systems operating above their design flows may require more frequent effluent filter cleaning. Clogged effluent filters will affect the dose rate of the pump, and the ability of the BSF to function properly.

(ii) If the pump vault is removed, the cleaned vault should be filled with clean water from a garden hose as it is being lowered back into the septic tank. This will prevent the screen from being fouled with solids in the tank and will also make it easier to submerge.

(iii) All slime material hosed off of filters, pumps and vaults should be placed into the **inlet end of the septic tank**, accessible through the tank inlet access riser / manhole**.**

(iv) All tanks and basins should be visually inspected for water-tightness and structural soundness when maintenance is performed.

Precautionary Note: To prevent contamination of the local water supply, a backflow preventer is necessary on all hoses used for maintenance.

GLOSSARY OF WASTEWATER TERMS

Biochemical Oxygen Demand - Five Day (BOD_5): A five day laboratory test which determines the amount of dissolved oxygen used by microorganisms in the biochemical oxidation (breakdown) of organic matter. BOD concentrations are used as a measure of the strength of a wastewater.

Bottomless Sand Filter: A sand filter used specifically as a dispersal / drainfield option for pretreated effluent which at least meets the BOD_5 and TSS requirements of 30 mg/l, and FOG of 5 mg/l. The filter is intermittently pressure-dosed with the effluent followed by periods of drying and oxygenation of the filter bed. Wastewater applied to the surface of a bottomless sand filter flows through that filter media once before infiltrating to the underlying native soils.

Dosing Tank: A tank that collects wastewater and from which wastewater is discharged it into another treatment or dispersal step; equivalent to a dosing chamber.

Drainfield (conventional): An area in which perforated piping is laid in drain rock-packed trenches for the purpose of distributing the effluent from a wastewater treatment unit.

Distribution Laterals (pressure dosed): Usually small diameter PVC pipe with orifices evenly spaced, used to uniformly distribute wastewater over a treatment zone in an enclosed component or drainfield.

Effective (Particle) Size, (E.S.= D_{10}): The size of a sand filter media grain in millimeters, such that 10% by weight of the media sample is smaller.

Effluent: Liquid that is discharged from a septic tank, filter, or other on-site wastewater system component.

FOG: Fat, oil, and grease contained in wastewater.

Fecal Coliform (bacteria): Coliform bacteria specifically originating from the intestines of warm-blooded animals, used as an indicator of pathogenic bacterial contamination.

Filter: A device or structure for removing suspended solid, colloidal material, or BOD from wastewater.

Filter Fabric: Any man-made permeable textile material used with foundations, soil, rock, or earth.

Filter Media: The material through which wastewater is passed for the purpose of treatment.

Influent: Wastewater being applied to a treatment unit or to a bottomless sand filter.

Particle Size: The diameter (in millimeters) of a soil or sand particle, usually measured by sedimentation or sieving methods.

Particle Stratification: Separation of particles according to size due to movement of particles in either air or water.

Soil Texture: The relative proportions of soil separates (sand, silt, and clay particles) in a particular soil. USDA soil texture abbreviations illustrated in Table 1 are defined as: cos = coarse sand; fs = fine sand; lfs = loamy fine sand; ls = loamy sand; fsl = fine sandy loam; sl = sandy loam; l= loam; vfs = very fine sand; lvfs = loamy very fine sand; vfsl = very fine sandy loam; sil = silt loam; vfsl = very fine sandy loam; si = silt; sicl = silty clay loam.

Total Suspended Solids (TSS):, measure of solids that either float on the surface of, or are in suspension in, water or wastewater. A measure of wastewater strength, often used in conjunction with BOD_5.

Uniformity Coefficient (C.U.): A numeric quantity which is calculated by dividing the size of a sieve opening which will pass 60% by weight of a sand media sample by the size of the sieve opening which will pass 10% by weight of the same sand media sample. Note that 50% of the sample is retained between the two. The uniformity coefficient is a measure of the degree of size uniformity of the sand particles in sand media sample. As the U.C. value approaches one (1), the more uniform in particle size the sand media is. The larger the U.C., the less uniform the particle size.

$$CU = \frac{\text{Particle Diameter}_{60\%}}{\text{Particle Diameter}_{10\%}} = \frac{D_{60}}{D_{10}}$$

Wastewater: Water-carried human excreta and/or domestic waste from residences, buildings, industrial establishments or other facilities.

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This document was based on the regulations and guidelines developed at:

Community Development Department, Environmental Health Division – Deschutes County, Oregon
Clackamas County Soils Department – Clackamus, Oregon
Washington State Department of Health – Olympia , Washington
Stinson Beach County Water District – California

The media sizing criteria, as used in Figure 9, was adapted from information provided by Orenco Systems, Inc., Sutherlin, OR, from the Washington Guidelines for Sand Filters and from information provided by Nick Hill of Holliston Sand Company, Inc., Slatersville, Rhode Island.

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Jerry Stonebridge – Stonebridge Construction Company, Inc. Freeland, WA.

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Mark Adams. Operation and Maintenance. Designers Requirements for Proper Operation and Maintenance of Bottomless Sand Filters. North Star Engineering. Chico, California, 2000.

Appendix A

Bottomless Sand Filter Figures and Schematics

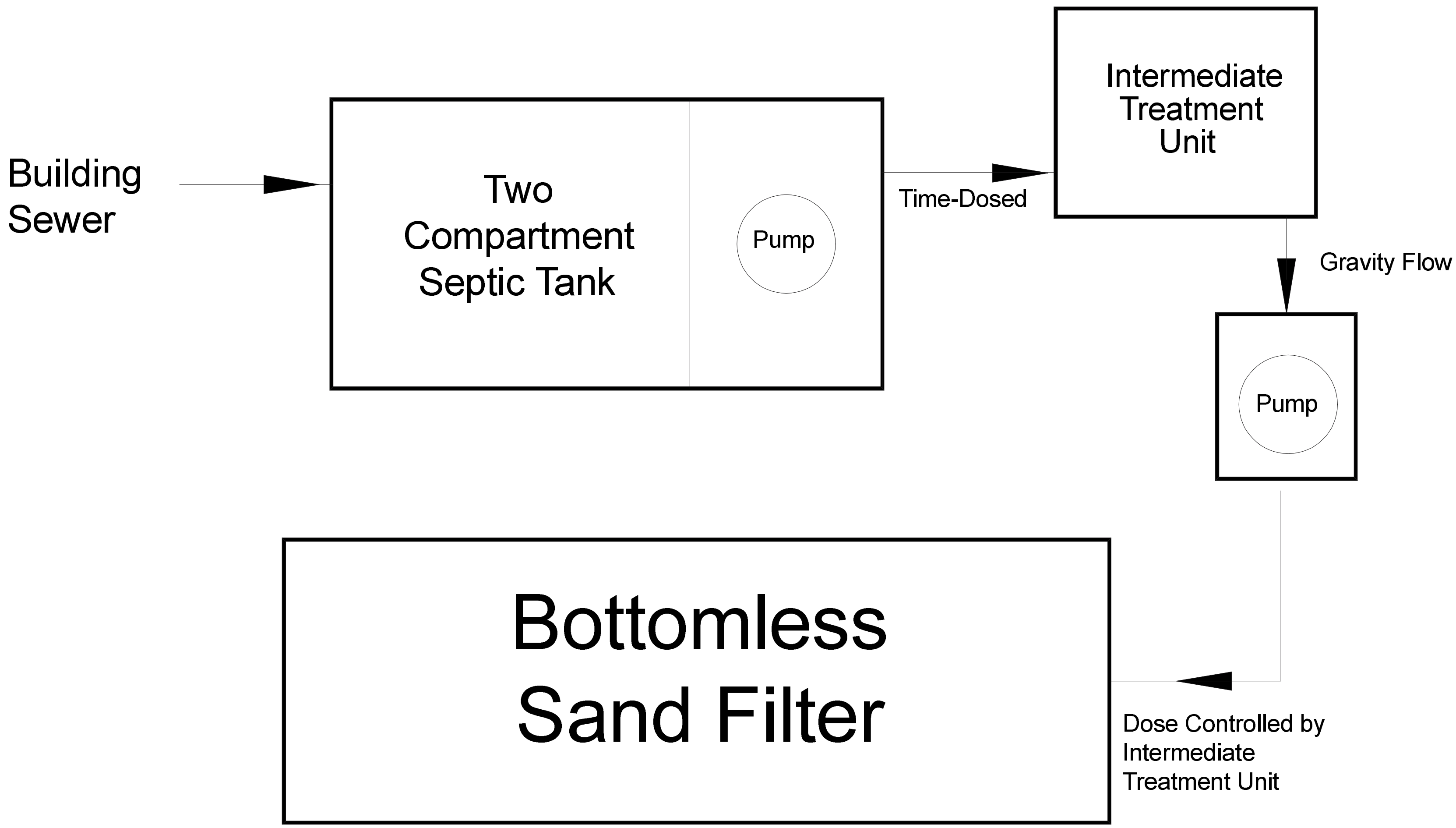


Figure 1: Treatment Train of a Bottomless Sand Filter Following a Timed-Dosed Advanced Treatment Unit (Category 1)

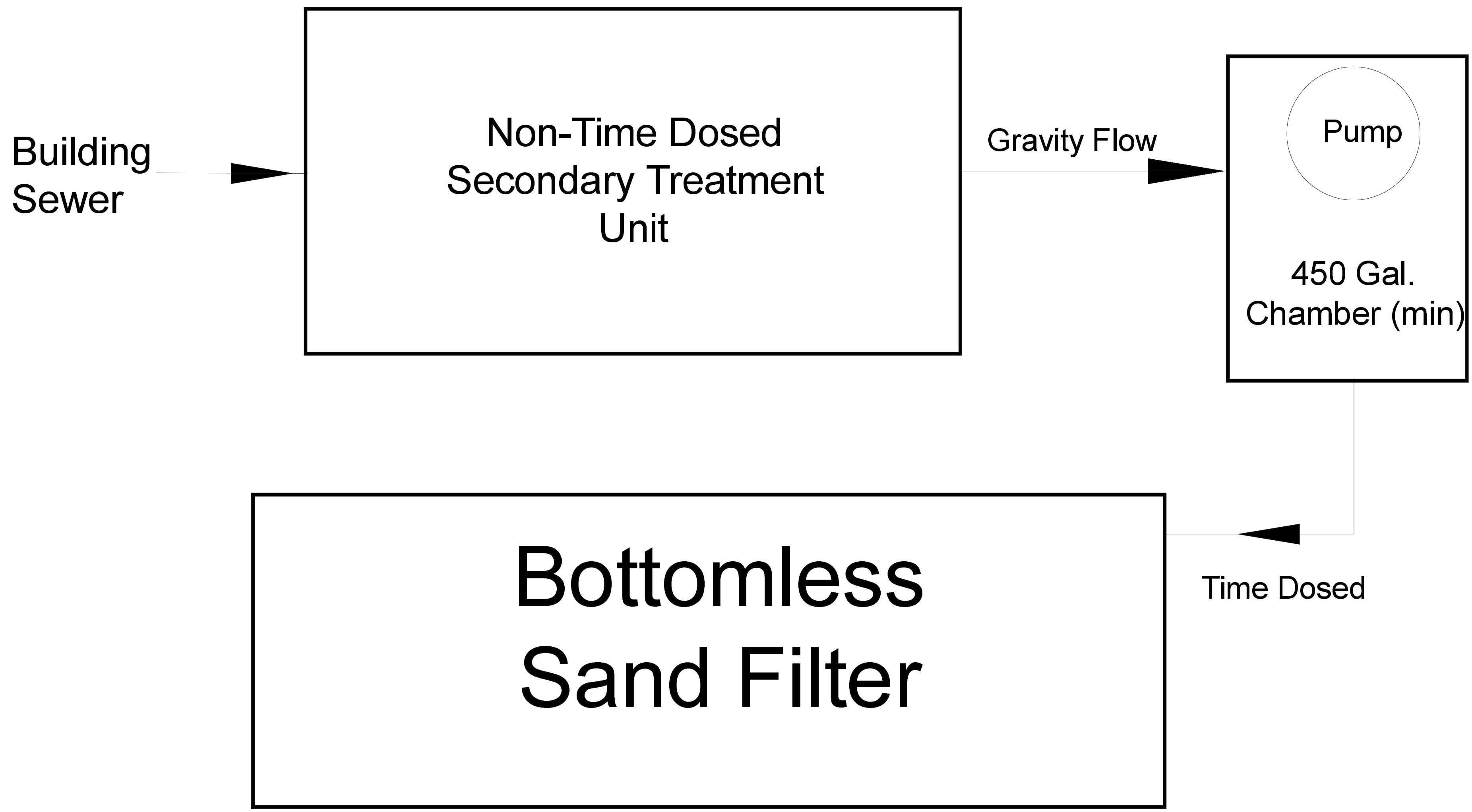
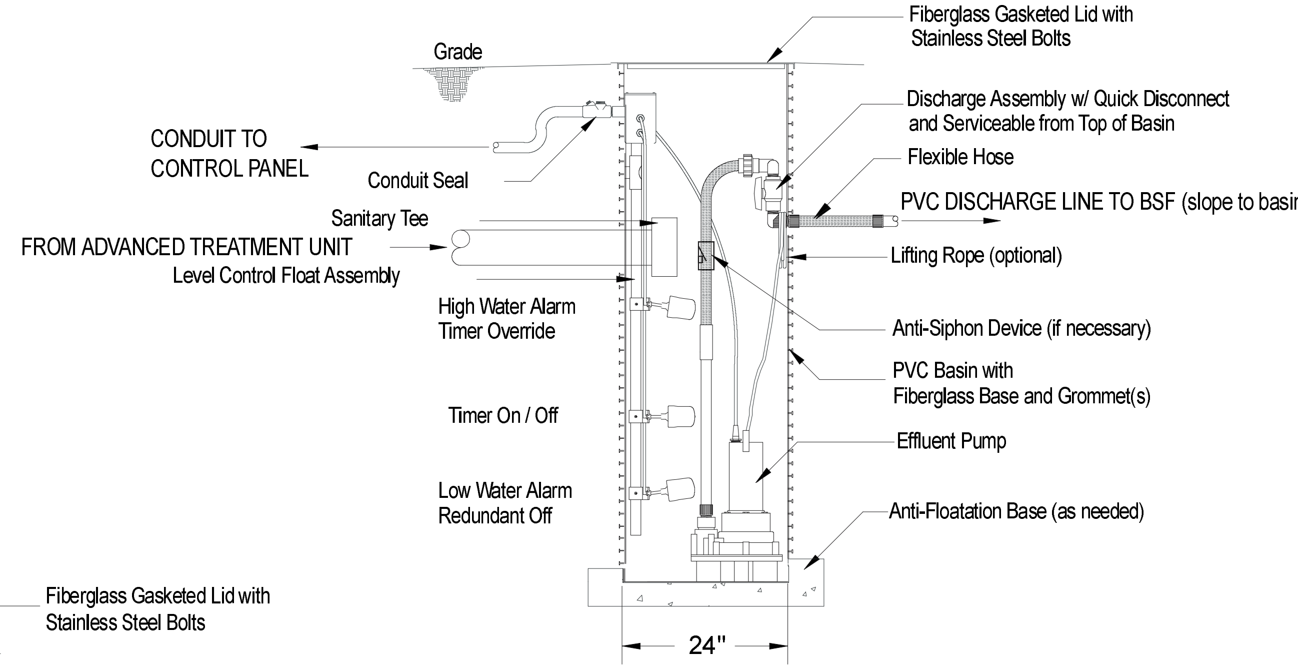
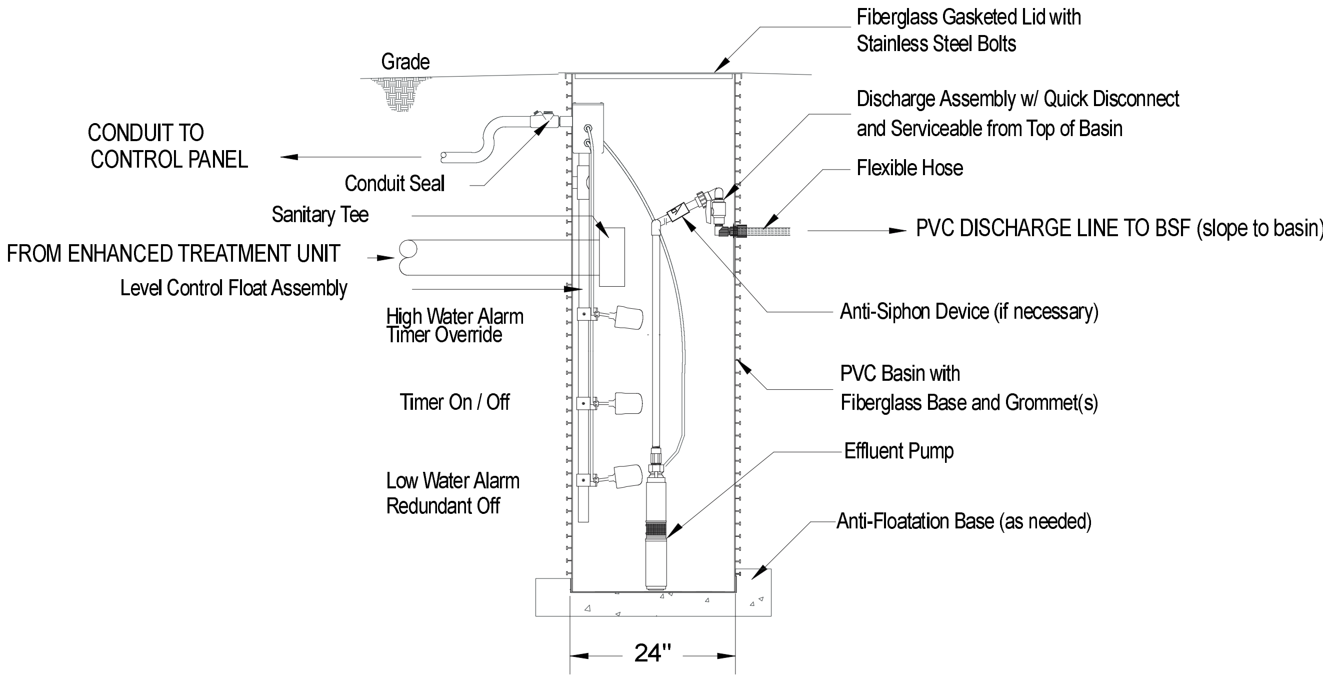


Figure 2: Treatment Train of a Bottomless Sand Filter Following
a Non-Time Dosed Advanced Treatment Unit (Category 2).



Low Head Pump

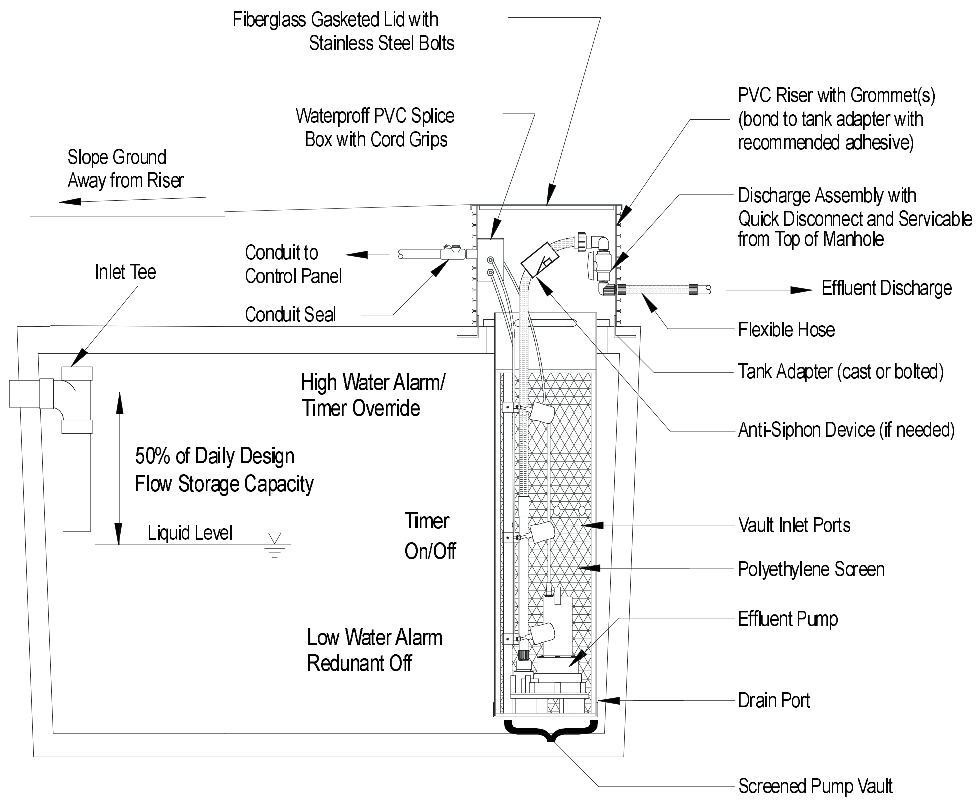


High Head Pump

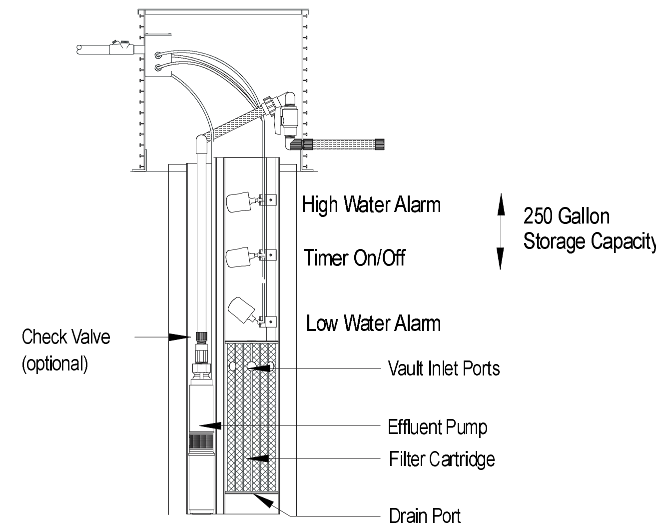
Note: Discharge assembly drawn to show key components - all piping and fittings shall be installed to ensure drain-back into the pump basin to avoid freezing of shallow bury discharge piping (where applicable).

Figure 3: Typical Pump Chambers to Follow a Time Dosed Advanced Treatment Unit (Category 1 Systems)

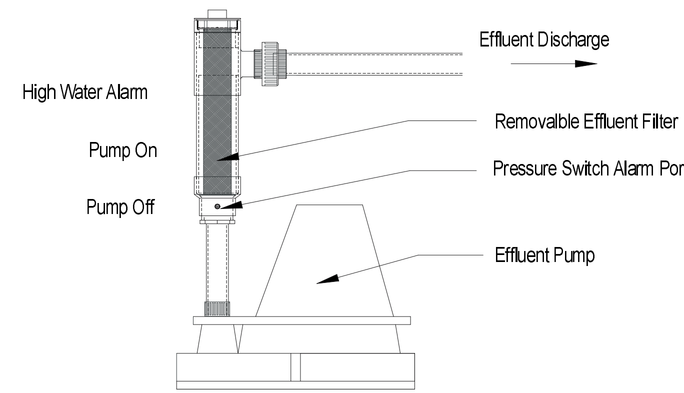
Note: Discharge assembly drawn to show key components
- all piping and fittings shall be installed to ensure drain-back into the pump basin to avoid freezing of shallow bury discharge piping (where applicable).



Low Head Pump with Effluent Screen

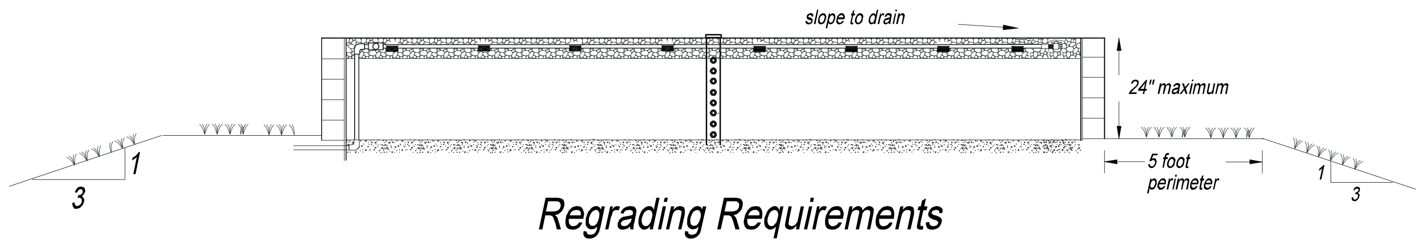


Optional Pump Vault - High Head Pump



Optional In-line Effluent Filter

Figure 4: Pump Chamber to Follow a Non-Time Dosed Advanced Unit (Category 2 Systems)



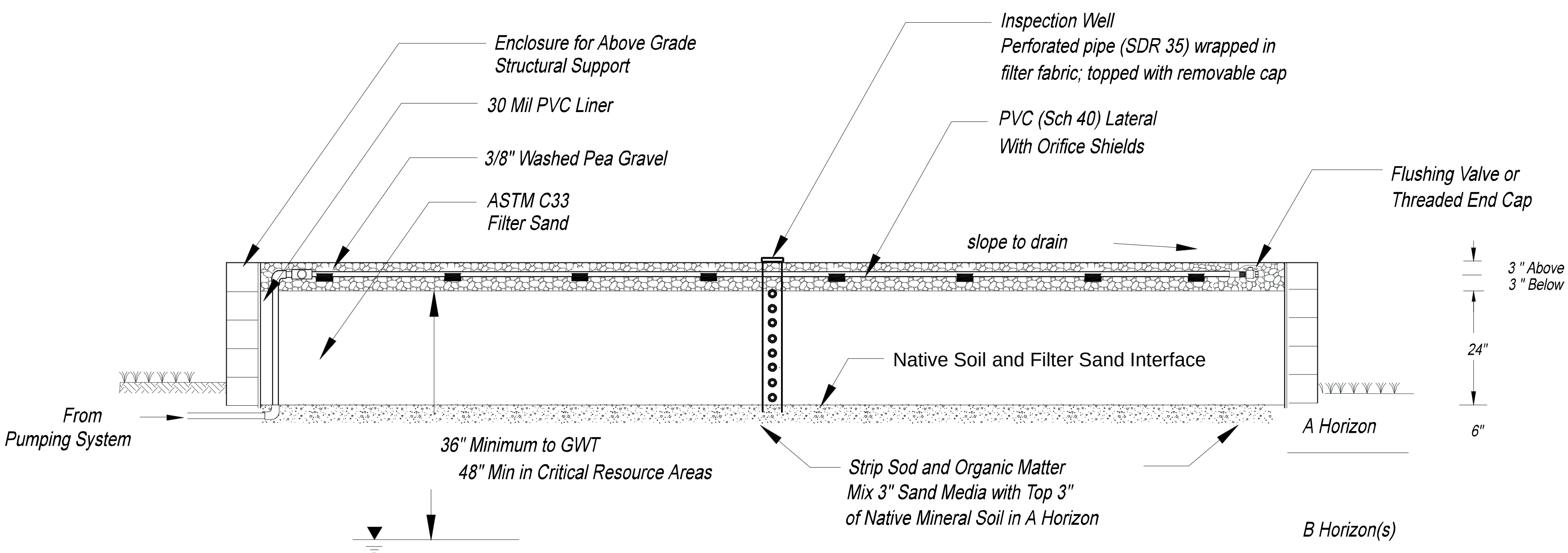


Figure 5: Bottomless Sand Filter Installed Above Grade (Cross Section)

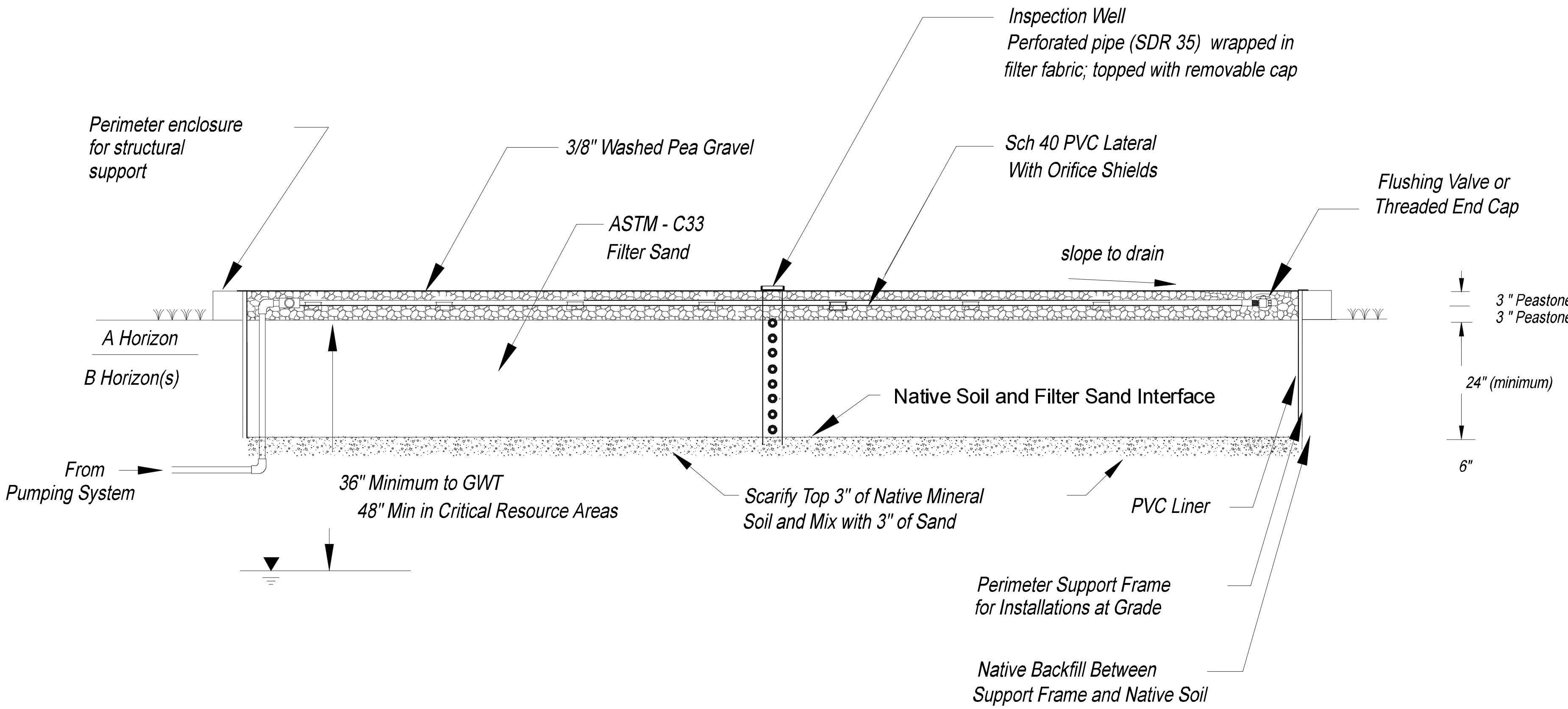


Figure 6: Bottomless Sand Filter
Installed At Grade (Cross Section)

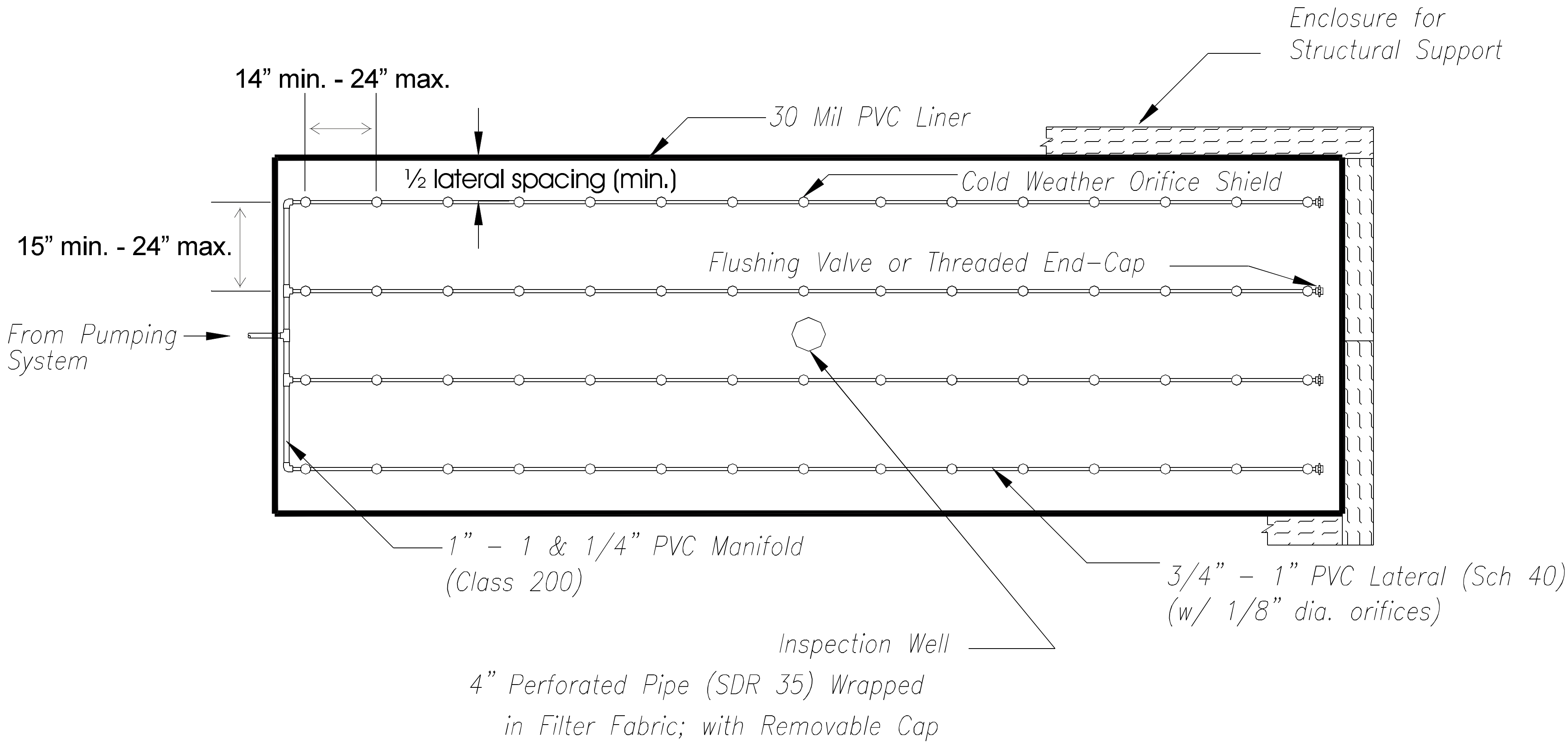


Figure 7: Typical Bottomless Sand Filter (Top View)

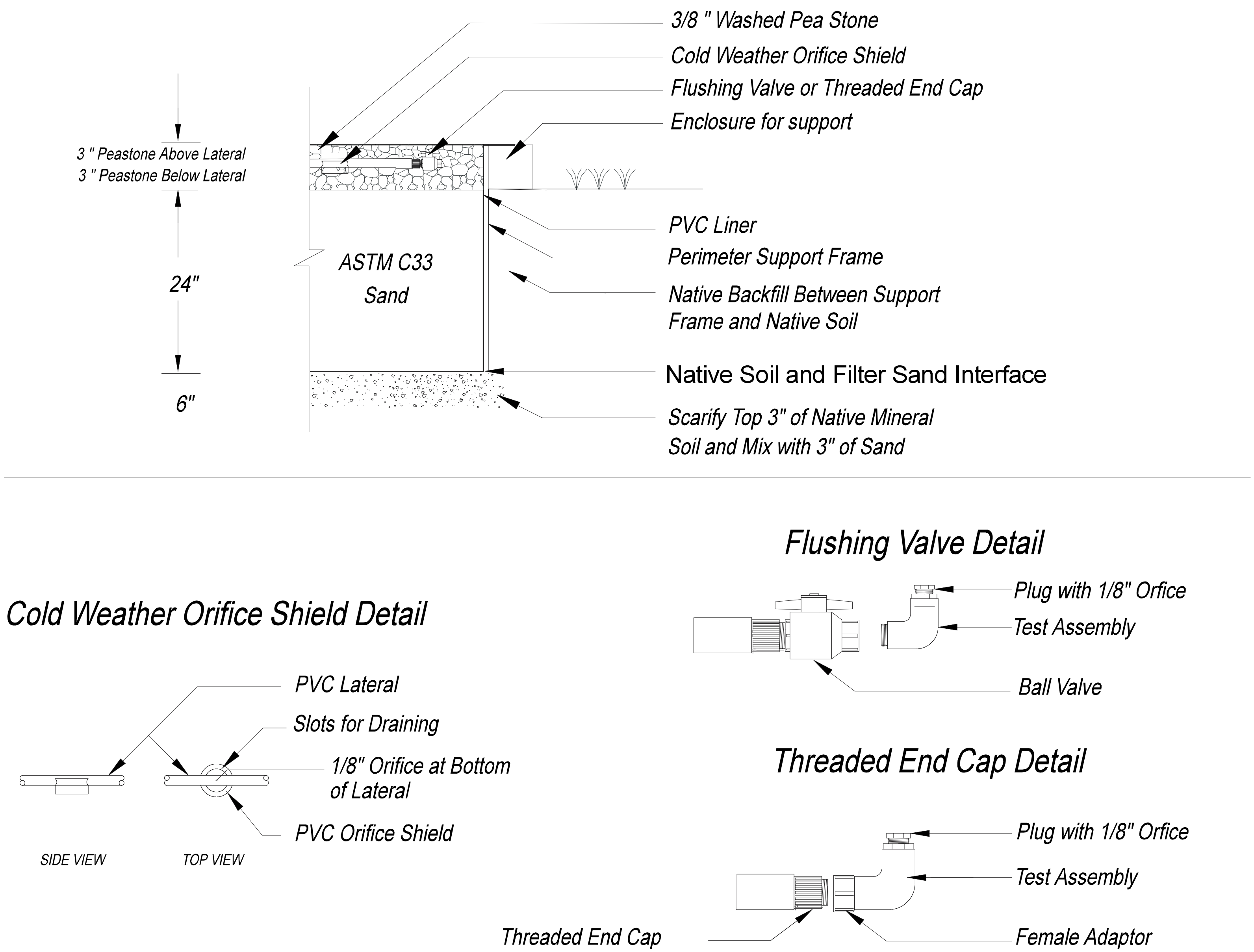


Figure 8: Bottomless Sand Filter Details

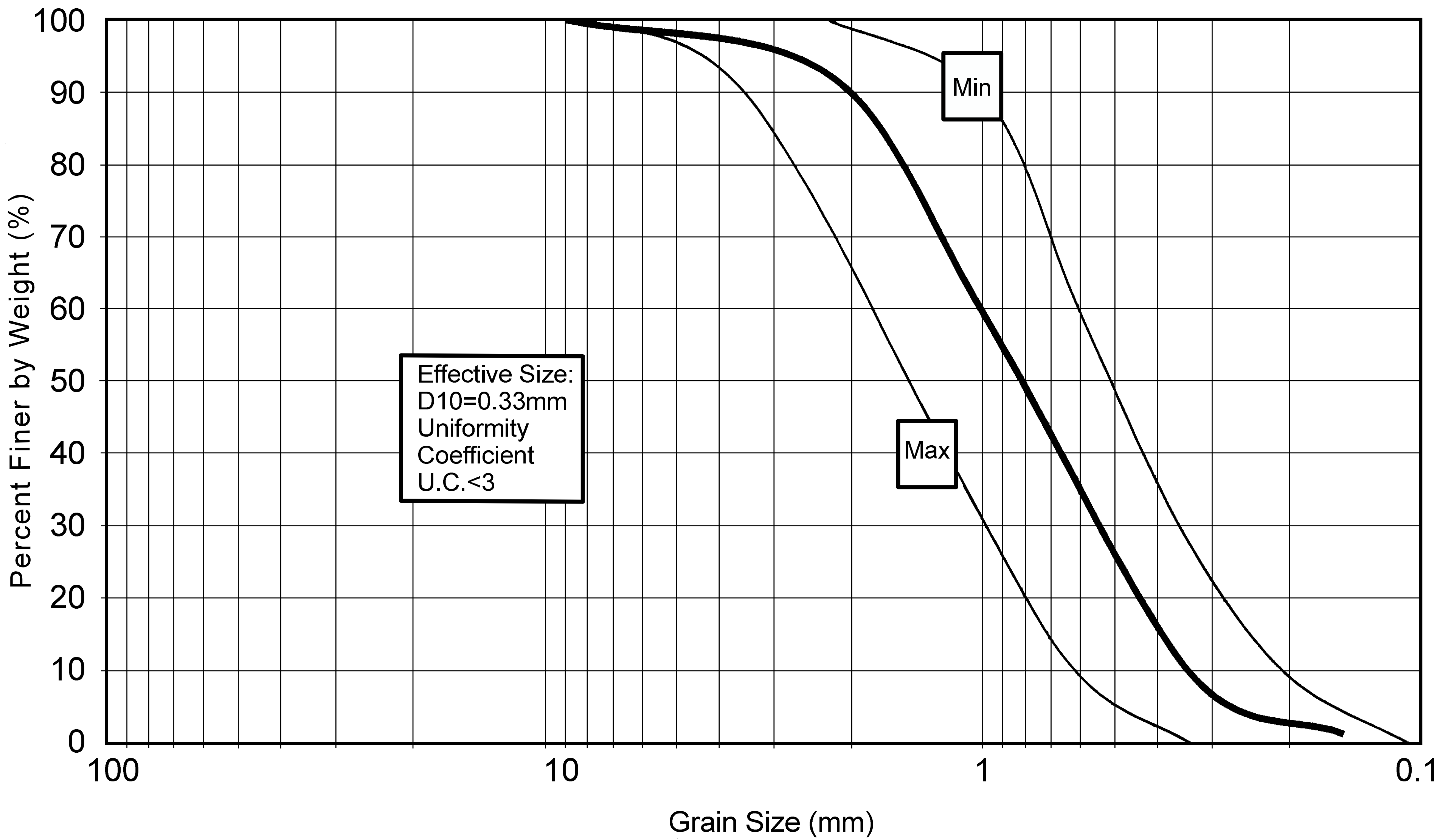


Figure 9: Bottomless Sand Filter
Media Specifications